

Amendment and Response
U.S. Serial No. 10/619,810
Filed: July 15, 2003
Inventors: Wilson et al.
Attorney Docket No: 210-589

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) An apparatus for measuring an operating parameter of a relay operating a pair of relay contacts, comprising:
 - a relay comprising at least two contacts, an armature controlling at least one of said contacts, and a solenoid coil having first and second terminals, said solenoid coil configured to move said armature in response to a control signal to cause said contacts to assume a condition selected from an open condition and a closed condition;
 - a voltage source connected to said first terminal of said solenoid coil, said voltage source further configured to provide a first reference voltage signal;
 - a voltage sensor having a first terminal connected to said second terminal of said solenoid coil, a second terminal configured to receive a second reference voltage signal, and a third terminal configured to provide a sensed voltage signal; and
 - a microprocessor-based programmable controller module comprising at least one analog-to-digital converter, said controller module configured to actuate said relay by providing said control signal to said relay, said controller module configured to receive a reference voltage signal based on at least one of said first and second reference voltage signal signals and said sensed voltage signal, said controller module configured to use said at least one analog-to-digital converter to convert said reference voltage signal based on at least one

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of said first and second reference voltage signal signals and said sensed voltage signal into respective discrete time sampled digital signals, said controller module configured to analyze said respective discrete time sampled digital signals;

whereby said apparatus measures an operating parameter of said relay when said relay changes said condition of said relay contacts.

2. (Original) An apparatus as recited in claim 1, wherein said sensed voltage signal comprises a voltage component representing a relay coil voltage, a power supply voltage component, and a voltage component induced by a motion of said armature.
3. (Original) An apparatus as recited in claim 1, wherein said controller module is further configured to cause said relay to change said condition of said relay contacts at a time when a selected one of a predefined voltage and a predefined current occurs therebetween.
4. (Original) An apparatus as recited in claim 3, wherein said predefined voltage is substantially zero volts.
5. (Original) An apparatus as recited in claim 3, wherein said predefined current is

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substantially zero amps.

6. (Original) An apparatus as recited in claim 3, wherein said apparatus further comprises a computer program recorded on a computer-readable medium, said computer program when operating on said controller module causing said relay to change said condition of said relay contacts at a time when a substantially predefined voltage will occur therebetween.
7. (Original) An apparatus as recited in claim 1, wherein said operating parameter of said relay when operating said plurality of relay contacts to change said condition of said relay contacts is measured in real time.
8. (Original) An apparatus as recited in claim 7, wherein said operating parameter of said relay when operating said plurality of relay contacts to change said condition of said relay contacts is measured with a precision of substantially 200 microseconds or less.
9. (Original) An apparatus as recited in claim 1, wherein said operating parameter of said relay when operating said plurality of relay contacts to change said condition of said relay contacts is measured in real time to within a desired angular precision of 30 degrees in phase.

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10. (Original) A method of controlling an operation of a relay having a plurality of relay contacts, a relay coil and an armature, said relay being powered by a power supply, comprising the steps of:

measuring a voltage signal across a relay coil as a first time sampled signal, said voltage signal comprising a relay coil voltage component, a power supply voltage component, and a voltage component induced by a motion of said armature;

measuring a reference voltage signal as a second time sampled signal;
analyzing said respective time sampled signals to measure an operating parameter of said relay; and

activating said relay according to said operating parameter so as to cause a change in a condition of said relay contacts selected from an open condition and a closed condition at a time when a selected one of a predefined voltage and a predefined current occurs therebetween.

11. (Original) A method as recited in claim 10, wherein said predefined voltage is substantially zero volts.

12. (Original) A method as recited in claim 10, wherein said predefined current is

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substantially zero amps.

13. (Original) A method as recited in claim 10, wherein a step of said method is performed under the control of a controller module programmed with a computer program.
14. (Original) A method as recited in claim 10, wherein a selected one of said first sampled time signal and said second sample time signal is measured in real time.
15. (Original) A method as recited in claim 10, wherein said operating parameter of said relay is measured with a precision of substantially 200 microseconds or less.
16. (Original) A method as recited in claim 10, wherein said operating parameter of said relay is measured in real time to within a desired angular precision of 30 degrees in phase.